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The Pennsylvania State College

The Graduate School

Department of Forestry

AN ECOLOGICAL STUDY OF THE RELATIONSHIPS BETWEEN FOREST TYPES AND THE WILDLIFE SPECIES FOUND THEREON

A Thesis

by

Russell Taplin Norris

Submitted in partial fulfillment of the

requirements for the degree of

Master of Science

June, 1941

Approved 22 May, 1941

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Introduction

One of the major projects undertaken by The Pennsylvania Cooperative Wildlife Research Unit shortly after its establishment in 1938 was entitled "An Economic and Ecological Survey of Pennsylvania." Under that comprehensive project this forest type-game range study was conducted. During the two decades since the appearance of the wildlife research worker, a vast amount of work has been done on the ecology and management of farm-game species, but ecological relationships and distribution of the respective forest-wildlife species in relation to cover types, however, have not been studied to any great extent. There has been a definite need for an adequate classification of forest cover types in relation to wildlife species, and it is the purpose of this study to attempt such a classification for Pennsylvania. If a satisfactory method of cover type evaluation is found, it is believed that the combinations of types, age classes, and densities of forests that provide the optimum for game and other wildlife species may be determined.

Review of Literature

In the past the only attempts to classify cover types in relation to wildlife species in this country have been based on ecological succession. Wight (1934) classified cover types in Michigan on a basis of origin and succession. He has since used that classification to very good advantage on farm-game species and their range in southern Michigan. No doubt the method can also be used on the forest lands of Michigan, where the plant succession is clearly understood.

Dalke (1937) used a similar method in Connecticut and apparently found it very satisfactory. He believes that cover types based on ecological succession are well adapted to other eastern localities. Not all States, however, are so fortunate in this respect as Connecticut where Nichols (1913, 1914, 1915, 1916) has described the vegetation of that State in great detail. In such an area where the ecological succession has been worked out, that has proven to be a fine basis for a type classification. Dalke is now working on a similar system in Missouri, and the method is being attempted in several other parts of the country.

Wight spent three summers investigating the forest types in various parts of Pennsylvania. In his unpublished manuscript (Wight, 1938), he comments on the lack of information and published material on the ecological succes-

sion of vegetation in Pennsylvania, and he attributes this condition to the fact that no plant ecologists have been developed who could give consideration to plant succession. He reviews what little literature is available, most of which concerns work done in adjoining States. No attempt at a classification is made, and it is obvious that none can be made until plant succession in the Commonwealth is understood more clearly.

Both foresters and plant ecologists have gone far in classifying the natural vegetation according to types and plant communities. The Committee on Forest Types of the Society of American Foresters (1932) compiled a list of forest-cover types of eastern United States, and this classification has been used by many writers in describing the vegetation of forest areas. Only major forest types were considered, however, and they were not broken down into communities small enough to be of value in forest-game-range descriptions. The plant ecologists of the United States and Europe have studied the vegetation in greater detail and have broken down the larger divisions of forest land into small units that are much more applicable for the wildlife manager. From the published works of the latter group, the writer has obtained valuable information relative to the break-down of forest areas into smaller units.

There are two great schools of plant ecologists, whose principles of classifying plant communities vary

considerably. Weaver and Clements (1929) are leaders in the American school and base their classification entirely on plant succession. Clements has worked extensively on the prairie land of the United States and has developed in many areas excellent methods of classifying communities on the basis of ecological succession. This method has been used by many others in the United States, and it has been very successful in regions where the dynamics of plant communities are relatively simple. In Pennsylvania, however, ecological succession is quite complex and has been so retarded by the activities of man that such a system is not practicable.

The European school is based along quite different lines, as exemplified in the text by Braun-Blanquet (1932). He has developed a method of classifying plant communities mainly on the basis of floristic composition and gives succession very little emphasis. The system of Weaver and Clements is criticized harshly by Braun-Blanquet because their classification is based entirely on the concept of the climax formation. Braun-Blanquet maintains that areas occupied by climax stages have become greatly reduced in size and that developmental stages occupy large areas. Braun-Blanquet believes that Clements' associations are large and difficult to grasp and that his subdivisions are indefinite. Though these are the sentiments of a rival school of thought--and therefore prejudiced--Clements' system is rather difficult to apply in enough

detail to be of great use for evaluating wildlife environment in central Pennsylvania.

Nichols (1923) discusses at some length the ecological classification of plant communities. He writes about the plant association as the fundamental unit of vegetation and its relation to the habitat. He discusses the classification of associations on the basis of physiognomy and ecological structure, on the basis of geographic relations, and on the basis of successional relations.

Terminology

From the work of Nichols and Braun-Blanquet the present writer has adopted a few terms. In developing a method of classifying the plant communities of central Pennsylvania in sufficient detail to be of use in evaluating animal habitats, terms had to be selected for various vegetational units. None of the plant ecologists had used a series of terms that fitted the scheme of classification this writer wished to follow; therefore, it became necessary to adopt parts of diverse systems. The method of Clements was unsatisfactory because of the basis of classification; his terminology was likewise unsuited to this study. Clements' association was too large and unwieldy a unit to be of much value in this type of work, and the subdivisions based entirely on succession could not easily be applied in this region. Clements and Shelford (1939) produced another series of terms in relation to communities, both plant and animal. These, however, were based on the principles Clements always followed and were not satisfactory. The consideration of the biome as a plant and animal formation was of interest, however, and was undoubtedly a step in the right direction--that of considering plant and animal communities as a unit.

A term was needed to apply directly to plant communities that occurred repeatedly over an area. In other words, some phrase was desired to describe a group of

plants that were usually associated. The word association seemed the most appropriate, but it had been used in so many different ways that the choice was not an easy one to make. While Clements' interpretation certainly did not fit the desired use, Braun-Blanquet's use of the term seemed more adequate. He used the definition of Flahault and Schroter (1910): "A plant community of definite floristic composition." Nichols (1923) described an even more suitable concept of an association as a plant community "essentially similar throughout in physiognomy, in ecological structure and in floristic composition." He also quoted Raunkiaer (1912) and Nordhagen (1919) as saying a plant association is "qualitatively and quantitatively a homogeneous plant community." In following the definitions of Braun-Blanquet and Nichols, the present writer believes that his interpretation of the term association can be clearly understood. The association need not be of any certain size or character, but it must have a definite floristic composition and be essentially homogeneous.

Nichols discussed associations from both the concrete and the abstract aspects:

> Viewed in the concrete, a plant association may be defined as a plant community characterized by its essentially homogeneous physiognomy and ecological structure and by its essentially homogeneous floristic composition, at least with regard to dominant species. Viewed in the abstract, the association may be defined as a vegetation unit characterized by an essentially constant physiognomy and ecological structure and by an essentially constant floristic composition, at least with regard to dominant species.

Nichols also introduced the term <u>association-type</u>, which may be of some use in this study. He defined it as follows:

> All associations which resemble one another in physiognomy and ecological structure, regardless of their floristic compositions, may be referred to a common ecological association-type.

> The association concrete is an example both of the association abstract and of the association-type. As an example of the first it is considered more especially with reference to its floristic composition. As an example of the second it is considered with reference to its physiognomy and ecological structure alone. Thus an individual pitch pine forest (association concrete) is an example of pitch pine forest (association abstract); it is also an example of what might be termed xerophytic coniferous forest (association-type).

After the association of Nichols had been selected as the most suitable term to use in describing the larger vegetation units, some simple subdivisions of the association were deemed necessary in order that smaller units might be well defined and fairly easy to recognize in the field. The writer felt, however, that the more simple the classification adopted, the more easily it could be applied to mapping and evaluating forest cover for wildlife. The facies as described by Braun-Blanquet (1927) was chosen as a major subdivision of the association. Braun-Blanquet's facies is "distinguished wholly by differences in the quantity or distribution of species, especially by the predominance of certain companion species of the association." This unit of vegetation can vary a great deal in

size and, of course, can vary considerably in composition. It may not be the best subdivision of an association, but it seems a very workable term and one that can be easily applied to this region.

Two terms used by Nichols (1923) as subdivisions of his association have been selected to subdivide the facies. In this study these terms can be used to better advantage by changing their definitions slightly and applying them to subdivide each facies of an association. The first, a layer society, may be defined as a plant community that results within a facies from the tendency of various species of smaller size than the dominant life-form to display their foliage at more or less definite levels. A layer society tends to be distributed more or less uniformly over the entire area occupied by the facies. The other subdivision, a group society, may be defined as a plant community that results from the aggregation within a facies to form more or less well defined clumps or masses of any species other than those which predominate in the facies as a whole.

In retrospect this classification may seem a little difficult to comprehend, but in reality it is quite simple. There are but six terms or units of vegetation employed: the association-type, the association abstract, the association concrete, the facies, the layer society, and the group society. As the first two are too large for general use, only the last four of these will be used extensively.

Association concrete is usually referred to simply as an association, meaning an individual, in contrast to the collective term association abstract.

Just how practical this classification will be remains to be seen, but it seems that in central Pennsylvania, at least, this system can be used quite easily and to good advantage. The value of this system may be more accurately determined after it has been applied to a few areas. It may become necessary to make a few alterations or even to change the entire system.

General Plan of Organization

Two forest tracts have been selected for study, each of which will be considered separately and described in some detail. Subjects such as size, elevation, topography, climate, soil types, location, ownership, history, and surrounding territory will be discussed. The vegetation will be evaluated and described in detail under several different plant associations common to each tract. Plant succession will not be considered except in special instances, as the writer is interested primarily in the cover type on the site at the present time. It is, of course, important to know the dynamics of the vegetation; but the present forest cover is the main issue and will therefore be the chief topic of the vegetation description.

The animal populations of each area will be considered, special reference being given the game species. Some of the game birds and mammals will be censused, and estimates of other animal populations will be attempted. Movements (especially in connection with various cover types) will be recorded, and all other ecological relationships on the area will be considered of paramount importance. Winter and summer photographs of the cover types are included for each area discussed.

The Barrens Study Area

General Description.

In broad, fertile Nittany Valley--between the Bald Eagle Mountains on one side and the Nittany and Seven Mountains on the other--there lies a strip of land known locally as "the Barrens." This huge area extends from Altro (near State College in Centre County) to Birmingham (near Tyrone in Huntingdon County) and includes more than 50,000 acres. In the past some of this land has been cleared for agriculture but has produced only meager returns. In the midst of this area just west of State College, about 5,000 acres of more sandy submarginal land has been selected as a study area. The study area may be roughly bounded by Scotia, Circleville, Juniata Junction, and Tow Hill. For clarity, the word "Barrens" in this report will refer only to the area delimited by these points.

A study area was established in the Barrens because of the abundance of game species and the importance of the forest types found thereon in central Pennsylvania. The area also presented an excellent opportunity to study the effects of fire and of man's activities on forest cover. The Barrens is extremely interesting from the plant ecologist's viewpoint for the vegetation is quite complex and many stages of plant succession are represented. It has been argued in the past that the types

found in the Barrens are not of enough importance in Pennsylvania to warrant the investigations that have been and are being conducted within its boundaries. Though very unproductive of timber, this land nevertheless merits wildlife research. The Barrens is not "barren" of wildlife; rather, it is very productive of wildlife. It has been estimated that two million acres, or approximately one sixth of the forest land of Pennsylvania, are occupied by what are known as scrub oak barrens (McIntyre, 1932). If this figure is correct--and the writer has no reason to believe it is not--much time should be devoted to wildlife research on the barrens of Pennsylvania.

The study area, a few miles west of State College, has a rather complex topography made up of many small knobs and irregular ridges. Most of the tract ranges from 1,300 to 1,400 feet above sea level, this elevation being 100 to 200 feet higher than the average of the surrounding agricultural areas. The change from one elevation to another, however, is not abrupt.

The soils of the Barrens are closely related to the limestone soils of the agricultural valleys. They are sandy and are derived from a mixture of sandstones, clays, and some limestones whose exact geological horizon has never been established. They occupy irregular and much-eroded ridges and have little water-holding capacity and have been classified in the Morrison series. The Morrison sandy loam is the soil type that is found over most of the

Barrens region. It occupies ridges and rolling-to-hilly areas and is very well drained. The surface soil consists of 8 to 12 inches of fine to medium yellowish-brown heavy sand or light sandy loam. The subsoil is a yellow or reddish-yellow, sticky sandy loam, which grades to a reddish clay at 36 inches. In the more loamy areas the surface soil is sticky when wet. Both soil and subsoil contain many sandstone fragments. The subsoil is porous and, though some water can be found at 30 to 60 feet, wells must be driven much deeper (300 to 600 feet) to obtain a satisfactory supply. The soil is derived from weathered sandstones and quartzites. The rocks and soil contain large amounts of iron ore, and several surface workings have been operated on the area. Other soil types in localities scattered throughout the Barrens are Morrison loam, stony loam, sand and clay loam, Hagerstown clay loam, clay and silt loam. These are of very little importance, however, as the Morrison sandy loam is the major soil type of the Barrens region.

The summer climate of this study tract is quite different from that of any other part of central Pennsylvania. The growing season is very short; the scrub oaks in the flats show no signs of life until very late in the spring, yet those same oaks turn red in the fall several weeks before frost appears in the surrounding country. The summer season (between the last killing frost in the spring and the first killing frost in the fall) is probably

not much more than 60 days. During July and August the noon temperatures are very high, whereas the minimum each night is close to the freezing point. In winter the climate of the Barrens is quite similar to that of the surrounding valley.

The area has an abundance of roads, some of which are passable for automobiles and some of which have nearly disappeared. Most of these are old logging roads, and a few are built on old railroad grades where the ties have been removed. These roads make travel possible to all sections of the Barrens, and they make the area accessible to a great number of hunters. In that they create openings in the dense growth of vegetation, the roads are of great value to the wildlife species.

The area is handicapped somewhat by the almost complete absence of water. A spring of soft water has been reported (Westerfeld, 1939) near Tow Hill in the western part of the study tract. It is the only water in the Barrens, with the exception of a few partly filled ore pits (Figures 1 and 2) and sinkholes. Some of these hold water throughout the year, but most of them dry up completely during the summer.

History.

The original forest cover and the conditions that brought about the present barrens type may be partly determined from the fascinating history of the Barrens. The accounts of early settlers tell of the splendid growth of

Figure 1. Ore pit near Scotia. Sept. 7, 1939.

Figure 2. Ore pit near Scotia. Jan. 31, 1940.

oaks, chestnuts, and pines that the Barrens supported. Some sections were once well stocked with oak and chestnut, and others supported heavy growths of white pine. Fine specimens of pitch pine and some Virginia pine were scattered throughout the area (Westerfeld, 1939). The undergrowth of ground oak, sweet fern, blueberry, and other shrubs was dense (Mooney, et al., 1910).

The Barrens was first settled in 1784, when Abraham Elder built a home in Half Moon Township. Small settlements soon began to spring up all through the region. Many of these settlers purchased their claims directly from the Commonwealth. Some of the land is still in the possession of the descendants of these first settlers, but the largest part of the area was bought by the Pennsylvania Furnace Company. The Roaring Spring Paper Company bought the land for lumbering purposes and held ownership until about 1900, when they sold to the Huyett and McNitt Lumber Company of Bellefonte. In 1923 Col. Theodore Boal of Boalsburg purchased the tract for $8 an acre. He expected to sell the land to the Government for a military reservation for the National Guard, but the deal did not materialize, and at present this land belongs to the Boal estate.

Mining had begun before 1800, and it increased steadily for over a hundred years. Furnaces were started in every part of the Barrens area, and these, of course, caused a tremendous drain on the timber supply for charcoal. The local ore went to Pittsburgh to be manufactured into

iron; this brought about an increased coal consumption, which in turn caused a great demand for mine props. The timber of the Barrens was soon exhausted, and second growth was cut in many sections. Most of the wood was used for charcoal and mine props, but much went into railroads, building materials, and telephone construction.

The annual fires of the region began shortly after the Pennsylvania Railroad opened a branch to Scotia Benore. Many of the fires were small, but some (such as the "Big Fire" of 1906, which threatened the town of Scotia for more than a day) did a great deal of damage. The only vegetative growth able to persist after these repeated fires was the fire-resistant pitch pine and the rapid-sprouting scrub oak.

Scotia was a prosperous town during the mining days and was inhabited by 400 people in 1895. This area is believed to have been the headquarters of Andrew Carnegie's first big mining venture. Fifty families remained in 1910, but mining had stopped the year before. Many houses were removed in 1911, and the railroad was taken up in 1921. A few families remained until 1924; the last buildings were torn down in 1937. All that remains of this once-prosperous community is a tumbled-down ore washer--a delapidated relic passed over by the wrecking crews.

Though minor lumbering operations were probably carried on by Indians and early settlers, the first big-

scale cutting operation started during the Civil War in the Pennsylvania Furnace section. Before 1900 the Roaring Springs Paper Company cut extensively in the "yellow pine area" from Scotia to Fairbrook. Huyett and McNitt of Bellefonte clear-cut between 1908 and 1918 all that was left on the area. The logs were transported over the tramroad to Waddle and manufactured into lumber, mine timber, and staves. It was reported that the timber had to be cut to save the trees from fires caused by the railroad, the situation finally becoming serious enough to warrant the hiring of a man to follow the trains and report fires.

After reviewing some of the history of this tract, it does not seem strange that the Barrens exists today. The forest was cut again and again and burned repeatedly until the present forest cover created an area almost worthless from a forester's point of view. In time the land may be brought back to timber-producing trees, but now the great value of this area lies in wildlife production.

Vegetation Types.

The vegetation on the study tract is rather difficult to describe because most of it is in a developmental stage. The area may be broken down into three major forest types: the oak-hickory climax association, the scrub oak-pitch pine developmental association, and the aspen developmental association. In the present study, plant succession was not of major importance because a description of the

forest cover currently occupying the ground was sufficient. But in an area like the Barrens, where the vegetation types are constantly changing, the dynamics of the community should be known.

In discussing the history of this tract, the many fires and repeated cuttings in the Barrens were mentioned. Analysis of the forest types of this region shows that most of the area is still covered with temporary communities and that the effects of the past have not yet disappeared. In fact, it will be many years before the Barrens again supports a climax forest.

The oak-hickory association occurs in several sections of the area, mostly on the higher land. Within this association there are several variations based on difference in quantity and distribution of the dominant species. This type does, however, appear homogeneous in floristic composition throughout the area.

The scrub oak-pitch pine association covers more acreage than either of the other two major types. It is a temporary plant community that follows heavy cutting and repeated fires in central Pennsylvania. Superficially examined, the association seems homogeneous throughout the area; but closer study reveals that species may predominate in one locality and be absent from another. The scrub oak-pitch pine association has therefore been broken down into several facies.

The aspen association covers only a small acreage and

is usually in very small stands. The writer is not sure just what place the aspen association occupies in the succession of the pine barrens. Apparently, however, this association comes in with the scrub oak-pitch pine type and will eventually be crowded out by the oak-hickory climax type. Many stands of aspen occur in the scrub oak-pitch pine association and likewise in the oak-hickory type. In the oak-hickory type the aspen is rapidly being overshadowed by the larger oaks, and a dead scrub-oak understory seems to indicate that not long ago the area was covered with scrub oak and pitch pine. A pure oak-hickory forest will result if no more cuttings are made and if fires are controlled.

This area can be broken down into three associations, but the boundaries of these are not always well defined. In many cases one type gradually changes into another, and the region where the change takes place can be classified as neither one type nor the other. Weaver and Clements (1929) have used the term "ecotone" for areas of this nature, and it will be good to use for these transitional areas in the Barrens.

Oak-Hickory Climax Association.-- On the study tract this association has been broken down into four facies, three of which definitely belong in this major type.

One of the most well-defined subdivisions of this association is the white oak-scarlet oak facies. White oak (Quercus alba) and scarlet oak (Quercus coccinea) are

the dominant tree species, comprising a very large percentage of the stand. In some localities red oak (Quercus borealis var. maxima) is fairly common, but nowhere is it so abundant as the other two species. Chestnut oak (Quercus montana) and black oak (Quercus velutina) occur occasionally, the former being on the highest elevations. Other tree species that are found scattered through this facies are red maple (Acer rubrum), hickory (Hicoria spp.), black cherry (Prunus serotina), largetooth aspen (Populus grandidentata), and pitch pine (Pinus rigida). Most of the area is fully stocked and even-aged. With the exception of two small sections that are 40 to 60 and 60 to 80 years old (Figures 3 and 4), the entire facies falls into the 20- to 40-year age class (Figures 5 and 6). There are a few older trees that were left when the area was last cut, but most of the oaks range in age from 27 to 32 years.

In this white oak-scarlet oak facies there are two unusual communities. One, found on the rocky points that are common to this territory, is made up of basswood (Tilia glabra), hop hornbeam (Ostrya virginiana), and occasionally slippery elm (Ulmus fulva). These are so distinct from the rest of the facies that they have been termed "fragmentary association." They are very small, but their occurrence in so many places deserves recognition. Another community that occurs in this facies frequently and that may be called a fragmentary association is the combination of black gum (Nyssa sylvatica),

Figure 3. White oak-scarlet oak facies.
60- to 80-year age class.

Figure 4. White oak-scarlet oak facies.
60- to 80-year age class.

Figure 5. White oak-scarlet oak facies in summer, 20- to 40-year age class.

Figure 6. White oak-scarlet oak facies in winter, 20- to 40-year age class.

green brier (Smilax sp.), and buttonbush (Cephalanthus occidentalis)--a combination that is often found around sinkholes. This growth is a distinct community and does not resemble the surrounding vegetation in any way.

The understory is very sparse throughout this facies except in a few places where the scrub oaks (Quercus ilicifolia and Q. prinoides) have persisted. Dead scrub oaks may be seen almost anywhere, but only a few live ones are left. Occasionally, in an open area where the canopy is not completely closed, a few scrub oaks remain to form a group society. Tangles of grape (Vitis spp.) are scattered over the area, but they are never very abundant. The smaller trees forming the understory are sassafras (Sassafras variifolium), a few oaks, black cherry, pitch pine, and an occasional small hickory.

The ground cover is not abundant over most of the facies, but many growths of deerberry (Vaccinium stamineum) and blueberry (Vaccinium vacillans and V. pennsylvanicum) occur in some sections. Where there is light, sweet fern (Myrica asplenifolia) forms dense stands.

In summary, this facies is mostly composed of even-aged stands that are stocked predominantly with oaks. There is very little understory, and the ground cover is very sparse except in certain limited areas.

The second subdivision of the oak-hickory association is the chestnut oak-hickory facies, which occurs only on the higher ridges in one part of the study tract. Chestnut

oak is the predominant species, always making up at least 30 percent of the stand and sometimes a great deal more. On the ridgetops chestnut oak is in practically pure stands, and in other sections it is mixed with white oak, scarlet oak, and hickory. Red oak, black oak, black cherry, largetooth aspen, red maple, sassafras, and pitch pine occur less frequently. Almost the entire facies belongs in the 20- to 40-year age class, but an occasional large white oak, scarlet oak, hickory, or pitch pine may be seen. Most of the area is fully stocked, but on the ridgetops and on the west slope the canopy is much thinner and the stand is understocked.

The black gum-green brier-buttonbush fragmentary association often occurs within this facies and is practically identical to the community that is found in the white oak-scarlet oak type.

The understory is thin over most of this area and almost absent from places where the chestnut oak is abundant. In the lower regions there are a few small oak, red maple, sassafras, hickory, wild apple (Malus sp.), shadbush (Amelanchier sp.), and chestnut (Castanea dentata) sprouts. On the ridgetops and on the west slope, where the canopy is quite open, much scrub oak still persists; on most of the rocky points throughout the area there are grape tangles (usually not very dense).

The ground cover is not abundant except on the ridgetops, where deerberry, huckleberry (Gaylussacia baccata),

and blueberry occur in dense stands. These ridgetops have a canopy that is not closed, and the various species of Vaccinium seem to do very well in this strong light.

The third subdivision of the oak-hickory association is called the mixed oak-hickory facies. It includes much more hickory than any other type in the Barrens. Hickory is one of the dominant species, along with scarlet oak, white oak, red oak, and some chestnut oak. This facies differs from the chestnut oak-hickory in that hickory is much more abundant and chestnut oak is less common. This mixed oak-hickory facies occurs on the highest ridge of the Barrens area and is probably closer to the true oak-hickory climax forest than any other of the facies described here. In addition to the species just mentioned, black cherry, red maple, largetooth aspen, and pitch pine occur occasionally in this facies.

The stand is even-aged and is in the 40- to 60-year age class, being slightly older than most of the other regions of the study tract. There are a few very large older trees that were spared when the area was last cut, but these are too scattered to be of much importance.

In this type are included a few sinkholes surrounded by the same black gum-green brier-buttonbush fragmentary association. Other sinkholes have a different community, with solid stands of leatherleaf (Chamaedaphne calyculata) in the center and dense growths of black alder (Ilex verticillata) and chokeberry (Pyrus melanocarpa) around

the outside. This sinkhole community may be considered another fragmentary association, as it certainly is no part of the mixed oak-hickory facies.

This facies is fully stocked in most places, but in some areas it is understocked. The understory is usually very dense, young oaks, hickory, red maple, and sassafras forming the small-tree layer. Scrub oak is dense in some sections, and although much of it is dead, some still persists under the more open canopy. Hazelnut (Corylus americana) is common on the south slope; chestnut sprouts, deerberry, huckleberry, blueberry, azalea (Rhododendron nudiflorum), sweet fern, and an occasional clump of prairie willow (Salix humilis) form the rest of the shrub layer in the understory. Further, all the rocky points have dense grape tangles. As ground cover there is a considerable amount of dewberry (Rubus villosus), wintergreen (Gaultheria procumbens), trailing arbutus (Epigaea repens), and club moss (Lycopodium sp.).

The fourth and last subdivision of the oak-hickory association does not really belong here, as it is a transitional stage or ecotone, where two associations are blending. It is, however, closest to the oak-hickory type and will therefore be included as a subdivision. This facies, which will be called pitch pine-mixed oak, is the most complex type on this study tract. It forms the transitional stage between the oak-hickory and the scrub oak-pitch pine associations; it can be classified as

neither one nor the other. It will develop into the oak-hickory eventually, however, and is being treated as a subdivision of it for that reason.

Pitch pine is the dominant species throughout this type. Scarlet oak is very common, and in some sections chestnut oak is the most abundant species. A few small hickories occur, and there are some white and red oaks, although they are not at all common. Red maple and black oak are very rare, but there is much largetooth aspen occurring both singly and in small stands. This type is uneven-aged, the pines being older than the hardwoods. The former are in the 40- to 60-year age class, whereas the hardwoods are about 30 years old.

The understory is fairly dense in most places and is composed largely of scrub oaks. The side of this area nearest the scrub oak-pitch pine association has the thickest scrub-oak growth; and the area closest to the oak-hickory association has much less scrub oak, most of which is dead or dying. There is a great deal of sassafras and chestnut-sprout growth throughout the area, and the young oaks, red maple, and hickory form part of the understory. The ground cover is also very dense, being composed of deerberry, huckleberry, blueberry, sweet fern, and wintergreen.

Scrub Oak-Pitch Pine Developmental Association.-- The Barrens received its name from this association and its outward appearance. This type occupies the largest part of

the study tract. There is, however, a great variation in the scrub oak-pitch pine type, owing to soil differences and varying age classes. The association has been broken down into several facies, and each will be discussed separately.

At one end of the study tract a large flat is covered by one of the most typical facies of the scrub oak-pitch pine association. It is called the scrub oak-pitch pine facies and is composed almost entirely of the two species of scrub oak and pitch pine. The oaks range in height from 3 to 6 feet and give the appearance during the summer of being very dense. Many small openings, however, covered with grasses and other herbaceous growth, are scattered through the area. Most of the pines are even-aged, being in the 20- to 40-year age class. An occasional black cherry may be seen (Figure 7), and there are a few small stands of trembling aspen (Populus tremuloides) in this type. The ground cover is, of course, very dense where the scrub oaks are small; and there is some blueberry, although it is not nearly so abundant as in other sections of this association.

The second subdivision of the scrub oak-pitch pine association is called the scrub oak facies; it consists of pure stands of large scrub oak and has very few other species present (Figure 8). This type is found along the sides of the ridges, between the oak-hickory association and the main body of the scrub oak-pitch pine association,

Figure 7. Single black cherry trees are found throughout the scrub oak-pitch pine association. Sept. 23, 1939.

Figure 8. Dense stand of large scrub oak.

and could be classified as an ecotone but really belongs in the latter association. The scrub oaks vary somewhat in age and range from 5 feet in height to an extreme of 12 feet in height and 3 inches in diameter on some locations. Throughout this facies the scrub oaks grow in such dense stands that it is very difficult for a man to force his way from one point to another. It is easy to understand why there is little ground cover under so dense a canopy, but in some of the more open areas wintergreen and trailing arbutus appear, being especially noticeable along the trails. An occasional pitch pine or shadbush (Amelanchier canadensis or A. oblongifolia) may occur in these dense stands of scrub oak.

The next three facies of the scrub oak-pitch pine association are quite closely allied, and all occur at the same elevation and on similar sites. There is, however, sufficient difference in the quantity and distribution of the species to warrant their separation into three distinct facies.

The first is the scrub oak-panicled dogwood facies, which occurs in the lower regions and extends up the draws onto the ridges for short distances. In this facies the two scrub oaks and panicled dogwood (Cornus paniculata) are the dominant species and comprise a large percentage of the stand (Figures 9 and 10). The scrub oaks range in height from 2 to 4 feet and are scattered over the area in groups, not in solid stands. The dogwood is about the

Figure 9. Scrub oak-pitch pine association.
Sept. 8, 1939.

Figure 10. Scrub oak-pitch pine association.
Jan. 31, 1940.

same size and is found mixed with the scrub oaks throughout the area. Many open areas are scattered through this type (Figure 11), and these are covered with grasses and other herbaceous plants. A few bushes of American hazelnut are mixed with these dominant species. Small stands of pure trembling aspen are very noticeable and form a definite part of this community, although they are classified in another association. Black cherry and shadbush are represented by individual trees occurring occasionally in this facies. A very few hawthorn (Crataegus sp.) bushes appear, and Porter's plum (Prunus alleghaniensis) is also quite rare. Small dense stands of prairie willow are along the roads and in all more or less open areas (Figure 12); and though this species is not scattered over the type generally, it is of great importance where it does appear. Another much smaller species, the low willow (Salix tristis), is found in two draws but is of no importance because of its rarity. Sweet fern is very common in certain sections and forms dense stands where it occurs (usually along roadways and trails).

In this facies are many sinkholes, most of which dry up in summer. Around these there is a community of plants somewhat similar to the fragmentary associations already described under the oak-hickory association. Black gum, green brier, and buttonbush occur; in addition there is considerable black alder, male berry (Lyonia ligustrina), cranberry (Vaccinium macrocarpon), chokeberry, and meadow

Figure 11. Many small open areas occur throughout the scrub oak-pitch pine type. Sept. 23, 1939.

Figure 12. Prairie willow along the roads is heavily browsed by deer during the winter.

sweet (Spiraea latifolia). These species grow on these moist sites to form very dense stands.

The ground cover in this type is dense over most of the area. Two species of blueberry and deerberry occur almost universally over the facies and usually form dense mats of ground cover. New Jersey tea (Ceanothus americanus) and wild rose (Rosa humilis) are common, and along the old railroad grades and roads there is a great deal of dewberry and sand cherry (Prunus pumila) in addition to small stands of prairie willow.

The next two subdivisions are so closely allied to the scrub oak-panicled dogwood facies that detailed descriptions of them will not be necessary. The first is the scrub oak-hazelnut facies (Figures 13 and 14). This is at the opposite end of the association and at the same elevation as that at which the scrub oak-panicled dogwood type is found. The great difference between these two facies is the change in the dominant species. In this, hazelnut takes the place of panicled dogwood and the three dominant species are the scrub oaks and hazelnut. The composition of the less common species is about the same, the same sinkhole communities occur, and the ground cover is quite similar. The variation in the quantity and distribution of the dominant species, however, warranted this breakdown.

The second of these closely allied subdivisions is called the scrub oak-broom sedge facies (Figures 15 and 16).

Figure 13. Scrub oak-pitch pine association showing small area of oak-hickory type on ridge top.
Sept. 23, 1939.

Figure 14. Scrub oak-pitch pine association.
Jan. 31, 1940.

Figure 15. Scrub oak-broom sedge facies with occasional aspen stand. Sept. 22, 1939.

Figure 16. Scrub oak-broom sedge facies with occasional aspen stand. Jan. 31, 1940.

Neither panicled dogwood not hazelnut occurs in any abundance, and the scrub oaks are the dominant species. Their size does not exceed 3 feet in height, and they are in scattered clumps, never in dense stands. Much of the area is open, and broom sedge (Andropogon scoparius) is the dominant herbaceous species in the open part. Broom sedge is prominent enough to be used in naming the facies but, of course, does not enter into competition with the woody plants. The ground cover is essentially the same as that described under the scrub oak-panicled dogwood facies, but this type has none of the sinkhole communities. Pitch pine does not usually occur in this region, but other companion species of the scrub oak-dogwood facies do.

The last subdivision of the scrub oak-pitch pine association is called the scrub oak-mixed oak facies. It is an ecotone but has been included in this association because the dominant species are the two scrub oaks. These scrub oaks are in very dense stands over most of the area and range from 4 to 10 feet in height. There are also many young white, scarlet, red, and chestnut oaks throughout this type. They are gradually coming in and will eventually form the forest cover there, scrub oaks being forced out. These oaks are about 20 years old. Red maple, flowering dogwood (Cornus florida), and staghorn sumac (Rhus typhina) also occur, but they are not common. In certain sections pitch pines are abundant (Figures 17 and 18), but they are absent from most of the

Figure 17. Scrub oak-pitch pine association.
Sept. 14, 1939.

Figure 18. Scrub oak-pitch pine association.
Jan. 31, 1940.

area.

The understory and ground cover in this facies are very dense. Sassafras, small hickory, and shadbush are associated with the scrub oaks. At a lower level dense growths of huckleberry, blueberry, and deerberry cover the ground. There is also a little mountain laurel (Kalmia latifolia). Wintergreen, trailing arbutus, and dewberry are common.

Aspen Developmental Association.-- This association does not cover a great deal of acreage on the study tract, but it is of sufficient importance to warrant classification as an association. Its importance in the plant succession of the area has already been considered, and its great value to game species will be discussed. This association differs from those previously described in that it does not stand alone, separate from other communities. It appears within the other two associations, not as a part of them, but as either a pioneer or a relic community of enough importance to be classified as a separate association.

In the scrub oak-pitch pine association the aspen community is represented by the many small stands of trembling aspen that grow throughout that type (Figures 19, 20, and 21). All these are fully stocked and usually even-aged, being about 20 years old. Very little understory or ground cover can be found under these stands, but occasionally there are a few small aspens. The

Figure 19. Aspen stand in scrub oak-pitch pine type.
Sept. 14, 1939.

Figure 20. Aspen stand in scrub oak-pitch pine type.
Jan. 31, 1940.

Figure 21. One of the clumps of aspen which occur throughout the scrub oak-pitch pine type. Sept. 22, 1939.

writer is of the opinion that these small stands of aspen in the scrub oak-pitch pine association are pioneer communities that will gradually increase in size and number and will eventually force out the scrub oak and pitch pine. Of course, the aspens will in turn be pushed out and replaced by the oak-hickory forest.

The other facies of the aspen association consists of solid stands of largetooth aspen growing on higher elevations in the oak-hickory climax type (Figure 22). These pure stands of aspen are usually small, but on one of the higher ridges there is an extensive area where only largetooth aspen occurs. In these stands there is little or no understory or ground cover, as the canopy is completely closed. They are even-aged, mostly between 20 and 40 years old. One facies, where these aspen stands constitute a large part of the area, is the transitional type of pitch pine and mixed oak. There solid stands of aspen can be seen, and their position in the plant succession of the area can easily be determined. They are relic communities of the once-dense scrub oak-pitch pine association, and now they too are being pushed out by the larger oaks. Undoubtedly, the largetooth aspen stands over the whole tract have a similar status in the succession, but in the pitch pine-mixed oak ecotone their position is most easily seen.

Animal Populations.

It is impossible to state in definite terms the

Figure 22. Aspen stand in winter.

abundance of most of the game species in the Barrens study tract, and estimates may sometimes be subject to considerable error. There are nine game birds and mammals in this area, and some population figures are available for six of them.

The Barrens is considered fine white-tailed deer (Odocoileus virginianus virginianus and O. v. borealis) range because good cover and plenty of low vegetation furnish food. During the summer of 1938 it was estimated that this tract supported 1 deer to 15 acres; and when the area was censused by airplane after the antlerless-deer season of that year, the tract showed 1 deer to every 18 acres (Bennett, English, and McCain, 1940). The deer herd suffered severely during the winter of 1939-40, however, and the population now is probably below that level.

During summer the deer feed in the low scrub oak-pitch pine association only at night and in the early morning. They spend a great deal of time during the day in the oak-hickory association on the ridge-tops and in the dense scrub-oak growth on the sides of the ridges (Figure 23). In July and August many deer were jumped from their "beds" when the writer walked through these types. The winter months after the hunting season are the most serious for the deer; then deer may frequently be seen feeding in the low scrub oak-pitch pine association at any time of day. During these months the willow

Figure 23. Low scrub oak in valley, high scrub oak on side of ridge, and oak-hickory type on ridge top. Jan. 15, 1940.

along the roads and trails is browsed heavily, perhaps because it is easy to reach and is located along the travel lanes, or perhaps because it is a preferred food. In years of good mast crop, scrub-oak acorns are undoubtedly an important item in a deer's diet until the supply is exhausted. Then throughout the winter the scrub oaks, dogwood, hazelnut, sweet fern, and willow on the flats furnish the food supply. During the severe winter of 1940 deer were frequently observed feeding on the lower branches of pitch pine in preference to many hardwood species.

The Barrens study tract is excellent cottontail-rabbit (Sylvilagus floridanus mearnsi) range, probably supporting as many rabbits as any similar area open to shooting in Pennsylvania. On a small 15-acre study area in the scrub oak-pitch pine association, John D. Beule, of The Pennsylvania Cooperative Wildlife Research Unit, found 1.4 rabbits to an acre. If this sample can be taken as representative of the remainder of that association, it indicates a high population of cottontails. Beule expressed the belief that the rabbits moved up the sides of the ridges into the dense scrub-oak stands during the winter and spent most of their time in the lower regions during summer. How important the aspen association is to the rabbit population, the writer does not know. Rabbits do, however, soon find a felled aspen tree and clean the bark from it in a very short time. Though aspen is a preferred food when available, this type probably does not

influence the rabbit population to any extent. The cottontail is not nearly so abundant in the oak-hickory association as in the scrub oak-pitch pine lands.

Eight woodchucks (Marmota monax monax) were on the same 15-acre study tract that supported 1.4 rabbits to an acre. Probably this figure of 1 woodchuck to 2 acres could not be applied to the entire scrub oak-pitch pine association, but if it is at all significant, it would indicate that the woodchuck is one of the most abundant mammals of that type. The woodchuck is common throughout the lower regions and is not a rare animal in the mixed oak-hickory association. The latter, however, does not support nearly so many woodchucks as are found in the scrub oak-pitch pine areas.

The gray squirrel (Sciurus carolinensis) occurs only rarely in the scrub oak-pitch pine association; the writer observed only one in that type during 2 years. Gray squirrels are quite common in the older oak-hickory associations. No accurate census figures are available, but a game-management class made a leaf-and-twig nest count in the oak-hickory type and observed 2.6 nests an acre. This figure serves only for comparison with a similar count made in a chestnut oak-pitch pine forest type in central Pennsylvania where 3.3 nests an acre were observed.

The ruffed grouse (Bonasa umbellus umbellus) is the most common game bird on the Barrens study tract. Popula-

tion figures on this bird are available from a 1,440-acre census area. This census area includes all the major cover types of the Barrens and is a very good sample of that territory. Allan T. Studholme and the writer censused the area by King's strip-count method on October 27, 1939, before the shooting season; on December 17, 1939, after the shooting season; and on April 19, 1940, after the winter season. The pre-hunting-season census revealed a population of 142 birds, or 1 grouse to about 10 acres. After the hunting season the population dropped to 109 birds, or 1 bird to about 13 acres. In spring, after the winter losses had been determined, there were 88 birds, or 1 grouse to about 16 acres. The population is expected to be higher in October 1940 than it was in 1939 before the shooting season.

Part of the census area is in the oak-hickory association, and part is in the scrub oak-pitch pine association; and a definite movement from one type to the other and back again was noticed both in 1938-39 and in 1939-40. The birds move into the dense scrub-oak growth just before and during the hunting season, and they remain there or close to it during the winter. In spring, just before the breeding season begins, the grouse move back into the more open oak-hickory forest, where most of the nests are located and many of the drumming logs are found. They remain there with their broods until fall, and then the same movement takes place again. There are two communities

that grouse frequent a great deal during certain times of the year. In the fall, when the panicled-dogwood berries are ripe, grouse will always be flushed near these dogwood thickets, being found in or near them until the fruit has disappeared. During winter and early spring, when grouse have to resort to budding for their food, they will usually be flushed near aspen stands. Grouse may be seen budding in aspen late in the afternoon or early in the morning, and undoubtedly the large amount of aspen on the area is very important to the ruffed grouse. They seem to prefer aspen buds to those of all other trees on the study area.

The scrub oak-pitch pine association might not be expected to make good woodcock (Philohela minor) nesting territory, but the American woodcock was quite common there during the breeding season in 1939 and again in 1940 (Morris, Beule, Studholme, 1940). In 1939 there were 45 singing male woodcocks, and in 1940 only 27 were recorded. These birds utilized only the scrub oak-pitch pine association as singing territories, no woodcocks being found in the oak-hickory forest. They sang from openings in the scrub oak-broom sedge facies in the lowest areas of the Barrens region. The writer believes that their diurnal territories were usually in the nearby aspen stands and in the dense scrub-oak thickets, although this has not been proved. They use the scrub-oak thickets as nesting cover, however, for in the spring of 1939 one nest was found in this type on the top of one of the

smaller ridges. These scrub oak-pitch pine lands do not serve as flight coverts for woodcocks in the fall; the birds leave during the latter part of the summer and are never seen there during the hunting season.

The wild turkey (Meleagris gallopavo silvestris) was a fairly common game bird in the Barrens during the fall and winter of 1938-39, and several broods were seen during the summer of 1939. In August of that year two hens were observed feeding in an open field with 15 half-grown poults. Other broods were observed throughout the summer, and eight birds were flushed in the oak-hickory forest type 3 days before the opening of the hunting season in 1939. A few were shot during the 1939 hunting season, but not enough to affect the population greatly. Turkey gobblers could be heard every day during the spring of 1939, but during the past spring the writer heard only two birds in the Barrens area. What happened to the remainder of the turkeys is not known. The writer is of the opinion that something happened to them before the heavy snowfall of February 1940.

Ring-necked pheasants (Phasianus colchicus torquatus) were common in the scrub oak-pitch pine association of the Barrens area during 1939, but the past winter has greatly lessened their number. In the spring of 1939 the cocks could be heard crowing throughout the area, but in the spring of 1940 it was unusual to hear a pheasant crow. The writer picked up a cock pheasant in March 1940--after

the heavy snowfall--and found it still alive but in an emaciated condition. There was very little flesh on either side of the breastbone, and the bird could hardly walk. Undoubtedly, this was typical of what happened to a large number of the pheasants on this area.

The Eastern mourning dove (Zenaidura macroura carolinensis), though not a game bird in Pennsylvania, is held in high esteem in the South. It is a very common species in the scrub oak-pitch pine forest type and frequently breeds there. Nests have been found on the ground and in pitch-pine trees at various heights. The birds arrive very early in spring and remain throughout the summer.

There are very few injurious avian predators resident in this region. Many Cooper's hawks (Accipiter cooperi) and sharp-shinned hawks (Accipiter velox velox) utilize the area during spring and fall migrations. Sparrow hawks (Falco sparverius sparverius) and red-shouldered hawks (Buteo lineatus lineatus) have been seen during migration, but no nests have been found. Two pairs of red-tailed hawks (Buteo borealis borealis), two pairs of broad-winged hawks (Buteo platypterus platypterus), and four pairs of marsh hawks (Circus hudsonius) were resident in the Barrens region during the summer of 1940. Several great horned owl (Bubo virginianus virginianus) pellets were found during the winter of 1938-39, but the birds were not observed. The writer has seen barred owls

(Strix varia varia), long-eared owls (Asio wilsonianus), and screech owls (Otus asio naevius) on the study area.

Foxes are not a serious predator, but during the past 2 years there have been two pairs of red foxes (Vulpes fulva) and at least one pair of grey foxes (Urocyon cinereoargenteus) traveling on the study area. The writer has seen their tracks several times but has never observed the animals, which have, however, been seen by others. The many old roads and trails make excellent travel lanes, along which they do most of their hunting.

Several farm dogs have been seen on the area, and four were shot during the spring of 1940. Several were seen chasing deer. These dogs probably did more damage than any other single predator. In 1939 four feral house cats were observed on the area. They have disappeared, however, and in the spring of 1940 only one was known to be present.

The striped skunk (Mephitis nigra) is a very common animal in both the oak-hickory and the scrub oak-pitch pine associations. There are probably more skunks in the latter type, but no preference of environment was observed. The opossum (Didelphis virginiana) is very common in the oak-hickory association near the rocky points and dense grape tangles. None have been observed in the scrub oak-pitch pine type.

Red squirrels (Sciurus hudsonicus) are not common

on the area, but a few occur in the scrub-oak flats where pitch pine has come in thickly. Only in those restricted areas has the writer observed any red squirrels. Chipmunks (Tamias striatus) are quite uncommon and have been observed on a very few occasions in the same type of vegetation. Flying squirrels (Glaucomys volans) occur on the area in the larger oak-hickory forest, but the writer has no idea as to their abundance because of their secretive habits.

The common weasel (Mustela noveboracensis), muskrat (Ondatra zibethica), and the raccoon (Procyon lotor) have been recorded from the study tract, but information relative to their numbers is lacking. The muskrat is found around one pond on the area, and that is the only available record of this animal. Two raccoons were taken by a trapper during the past winter from the older oak-hickory type, where many sinkholes occur. Although the writer has seen only three on the area, the weasel is probably a fairly common animal. Weasel tracks have been seen, and several scats have been collected. Weasels are found in both the oak-hickory and the scrub oak-pitch pine association.

Very little trapping for small mammals has been done on the study tract, but the following are known to occur: White-footed mouse (Peromyscus), meadow mouse (Microtus), lemming (Synaptomys), red-back mouse (Evotomys), common mole (Scalopus), hairy-tailed mole (Parascalops), long-

tailed shrew (Sorex), pigmy shrew (Microsorex), and mole shrew (Blarina). The little brown bat (Myotis lucifugus) is also a common summer resident of the Barrens.

A complete list of the song and insectivorous birds that have been seen on the study area is unnecessary here, but a few birds are so abundant that they may be of importance as buffer species. In summer the towhee (Pipilo erythrophthalmus erythrophthalmus) and the brown thrasher (Toxostoma rufum) occur in large numbers in the scrub oak-pitch pine association; the flicker (Colaptes auratus luteus) and the whip-poor-will (Antrostomus vociferus vociferus) are only slightly less common. The blue jay (Cyanocitta cristata cristata) and the slate-colored junco (Junco hyemalis hyemalis) are the most common small birds seen there during the winter. Avian predators have left remains of all these species; and the towhees, brown thrashers, and blue jays are undoubtedly important items in the diet of resident hawks and owls.

The Seven Mountains' Study Area

A second study area was established in the Seven Mountains, about six miles south of State College. This tract of land included the first three parallel mountain ridges that comprise the Tussey range and is about seven thousand acres in area. This region was selected for study because of the great contrast between it and the Barrens area. The two regions represent widely different vegetation types; one being made up of low scrub growth in a developmental stage, and the other being mainly composed of timber trees. These two tracts also offer a marked contrast as game ranges--the Barrens area being excellent game cover and the Seven Mountains not nearly as productive.

The topography of the Seven Mountains tract is rugged, being located in the midst of a series of parallel ridges. The elevation varies from 900 to 2100 feet. The upper slopes are steep and in many instances precipitous, and the summits are narrow. The lower slopes merging into the valleys are usually long and gentle.

The mountain ridges of this study area owe their presence to the resistance of the sandstones of which they are composed. The sides of these mountains are flanked by shale and slats formations, which form the gentle slopes from the foot of the steep or precipitous part of the ridges to the valleys below.

On the lower slopes of the mountains, the Dekalb clay loam usually marks the upper limit of cleared land, the Dekalb stony loam and Rough stony land above it being timbered. This soil type formerly supported a fair growth of chestnut and other hardwoods and pine. At present it is mostly devoted to pasture.

The surface soil of the Dekalb clay loam, to a depth of six to eight inches, varies from a heavy silt loam to silty clay loam, the latter texture being the more general. The color changes from drab or brownish on the immediate surface to pale yellow beneath. The first few inches of the subsoil is composed of a pale-yellow heavy silty clay loam which generally grades with depth into heavy plastic silty clay, usually yellow somewhat mottled with red and white or drab and brown.

Bands of Dekalb stony loam are found along the slopes of the mountain ridges in the valley sections. The areas lie between the loam and clay loam types of the lower slopes and the Rough stony land of the crests and steep upper slopes. The surface soil of Dekalb stony loam varies from a heavy sandy loam to a clay loam, with the predominating texture a medium loam. The color is brown or yellow brown. The subsoil is heavier, ranging from a clay loam to a clay, at depths of from 8 to 10 inches.

Throughout this region the many steep tree-covered slopes have been mapped as Rough stony land. The agencies of erosion have been so active in these areas as to remove

practically all of the surface soil and to preclude the possibility of ever using this land for agricultural purposes.

The climate of this mountain area is quite similar to that of the surrounding territory in the broad valleys. The snowfall is slightly heavier on the ridges, and in the spring snow persists on the north slopes until long after it has disappeared from all other surrounding territory.

There are several first class gravel roads through the study area, making it very accessible to hunters. These roads usually follow the valleys and cross the ridges only in the lower gaps. There are many foot-trails crossing the mountains throughout the area, however.

In contrast to the Barrens area, this region has plenty of water. Each valley contains a good sized stream, and in two of the valleys these streams have been dammed. Considerable water has been impounded in each case, and the resulting ponds attract a good many waterfowl during migration. There are also many springs on the upper slopes of the mountains, which contain water throughout the summer.

No such detailed history of this area is available as was the case with the Barrens tract. However, the area has been cut over and the existing timber is composed of second growth trees. No extensive cutting

operations have been carried on in the tract since the latter part of the nineteenth century, and, therefore, the forest growth is entirely in the timber producing stage. Because of this and the lack of an adequate understory, this region is not as productive from the game standpoint as the Barrens area.

Vegetation Types.

During the course of this study much more time was spent on the Barrens area than on the Seven Mountains tract, and, therefore, the vegetation and animal populations of the latter are not as well known. Due to a change in plans, the writer was not able to devote the time needed to correctly evaluate the vegetative types of the mountain region.

The vegetation of the Seven Mountains is much less complex than that of the Barrens. The forest growth is not in a highly developmental stage as is the Barrens vegetation. Of course, all the types are not in climax stages, but the succession is more simple and has not been constantly retarded by the activities of man.

There are three major forest types of this mountain region: the chestnut oak-pitch pine association, the oak-hickory association, and the hemlock-rhododendron association. In addition to these types, some of the area is in old fields with Virginia pine scattered throughout. These three associations are quite well defined on the area and are closely correlated with the

topography. The chestnut oak-pitch pine association occurs only on the ridge tops and sometimes a short distance down the slopes. This type, together with the hemlock-rhododendron association does not cover a great portion of the area. The main forest type is the oak-hickory association which covers the entire slope of every ridge from the chestnut oak-pitch pine type of the summits to the hemlock-rhododendron type of the bottom lands. This latter type is found only along the streams in the narrow valleys of this mountain region. Occasional old fields are to be found scattered throughout these valleys.

These association boundaries are not always well defined, but the types tend to form rather definite lines of demarcation. There are only a few ecotones on this area, whereas in the Barrens region a mixture of types is quite common.

Chestnut Oak-Pitch Pine Association.-- The chestnut oak-pitch pine association is a climax type and is essentially the same throughout this mountain region. The most significant variation is in its age class, and a very large percentage of it is in the 60- to 80-year age group. Some are older and occasionally younger stands may be found. For the most part, however, this type consists of massive chestnut oaks with crooked trunks. Pitch pine is the next species in abundance, but the chestnut oak outnumbers all other species combined.

Large black birches are fairly common in some sections, with some yellow and white birches scattered throughout the area. Black gum, shadbush, butternut, chestnut sprouts and an occasional striped maple complete the list of tree species to be found in this type. In most sections the ground is covered with a dense layer society of deerberry and mountain laurel. A great deal of light reaches the ground through the very open chestnut oak canopy and the mountain laurel seems to thrive on the rocky ridge tops.

Oak-Hickory Association.-- The oak-hickory association is the important climax type of this region (Figures 24, 25, and 26), covering a large percentage of the area. It is largely in the 40- to 60-year age class, having been cut over during the latter part of the nineteenth century. The most important species are hickory, red maple, white oak, scarlet oak, chestnut oak, red oak and black oak. These form nearly the entire stand and other species are merely scattered here and there. These additional tree species include sassafras, black gum, tulip poplar, shadbush, black cherry, white ash, flowering dogwood and chestnut sprouts. The canopy is quite well closed and the understory is generally sparse, but occasionally small stands of mountain laurel may be found as well as some deerberry and considerable witch hazel. Throughout this association there are many group societies of large-toothed aspen and also a few single aspens scattered over

Figure 24. Predominant type of Seven Mountains area--the oak-hickory association--September, 1940.

Figure 25. Predominant type of Seven Mountains area--the oak-hickory association--September, 1940.

Figure 26. Predominant type of Seven Mountains area--the oak-hickory association--September, 1940.

the area.

Hemlock-Rhododendron Association.-- This association is confined to the bottomlands and usually is found bordering a stream or swamp. The hemlock is the dominant tree species and in some sections individuals reach huge size. Over most of the area covered by this association, however, the hemlock is small and associated with dense growths of rhododendron (Figures 27, 28, and 29). Tulip poplar, black gum, red maple and sassafras are found in close association with it usually. In some places dense clumps of mountain laurel are found, and witch hazel and green brier are occasionally present.

The Old Field Type.-- Although too small to be of much importance, a portion of this area is covered with an old field type with Virginia and table mountain pines scattered throughout. These old fields are usually in the bottomlands adjacent to dense growths of hemlock and rhododendron.

Animal Populations.

The Seven Mountains area supported two or three black bear, but these traveled a great deal, of course, and were constantly moving on and off the tract.

The deer population was estimated to be about 1 deer to 50 acres during the summer of 1938, and a census from an airplane after the antlerless deer season showed a population of 1 deer to 72 acres. Pellet-group counts were made in 1938 and 1939, and before the hunting season

Figure 27. Dense stands of rhododendron under hemlocks.

Figure 28. Dense stands of rhododendron under hemlocks.

Figure 29. Hemlocks that have been browsed by deer offer no food during the winter.

of 1939 the area was believed to support 1 deer to 60 acres (Bennett, English and McCain, 1940).

During the summer deer feed a great deal in the few open fields that are in the valleys. Most of this feeding is done at night, and during the day they rest on the ridges. In a normal winter they usually range over the entire area in search of the little food they can find, but in a winter like 1939-40 most of the deer congregated in the dense hemlock and rhododendron stands in the valleys. There they are forced to feed on rhododendron leaves and twigs and the hemlock boughs which they can reach--foods that will not maintain the weight of a deer unless supplemented by additional nutrients.

No grouse census area has been set up in this region, but grouse are not very common over the tract as a whole. Where good food and cover occur in certain sections of the valleys, a few grouse may be found. Occasionally a group may be flushed from the laurel or deerberry thickets on the ridges, but these coveys are scattered. The grouse population on the area would not be more than a bird to 50 acres, and this figure is undoubtedly high. Mature timber and a bare forest floor cover too much of the area to produce many grouse. Those that do occur are only local concentrations.

This mountain area is much better gray squirrel range than the Barrens region. As previously mentioned, a leaf-and-twig nest count in the chestnut oak-pitch pine

type of this area revealed a figure of 3.3 nests per acre. The abundance of the chestnut oak acorns is to their liking and in most sections gray squirrels are very common.

The Seven Mountains area has passed beyond the stage of usefulness for most species of wildlife, but the huge mast trees and rather open woodland combine to form fine wild turkey range. This area maintained several large flocks of wild turkeys, and they should do very well there for many years to come. The large chestnut oaks produce a great many acorns, which are fine turkey food, and the open country is also well suited to turkeys, as they travel great distances and have wonderful vision.

The cottontail and woodchuck both occur on the area, but, being mainly forest land, it does not support appreciable numbers of either species. The woodcock has been observed feeding on the area, but no records of its breeding there are available. However, several pairs do breed and nest close by in the more open adjacent valleys.

It is impossible for the writer to present any population data on avian or mammalian predators or small birds and mammals. The common hawks and owls of the general region have all been observed on the study area, and at least a few of them breed there. Both species of foxes occur and are more common than in the Barrens area. Skunks and opossums are not as common as in the latter region, but the mountain area supports good populations

of weasels, raccoons, and a few mink and muskrats.

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